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SOME PINEAPPLE PROBLEMS.

17th ARTICLE. - THE PLANT NUTRIENTS.

By Henry C. Henricksen.

W A T E R. - While carbon is the only element derived from the air and while all the other nutrients enter through the roots, the pineapple plant is not entirely dependent upon its roots for sustenance. Water enters through the white leaf-bases when it is present there, which it frequently is, because the leaves are arranged on the stalk so as to retain considerable amounts. In experiments with slips and suckers, the bases of which were sealed over with melted paraffin or shellac, it was shown that the water intake through the leaf bases more than balanced the transpiration loss for several weeks. That is, while the slips are fresh, after having been kept for some time before planting they gradually lose the capacity for water absorption. Therefore, the water absorption through the leaf bases is perhaps not of much importance to the newly planted slip, for it has usually been kept so long that it has lost its capacity for absorbing. Also, the leaf area is so limited that whatever rain or dew remains in the leaf-bases soon evaporates. With the growing plant the case is different. The leaf-bases are in condition for absorbing water and the leaf area is large enough to allow for considerable rain or dew being retained. As to water absorption by the roots from soils with different moisture content the reader is referred to the second article of this series published December, 1924.

NITROGEN. - As this was discussed in the 15th article only certain phases of the subject will be treated in this one. The experience that ammonium sulphate produces normal vigorous growth in the field, where nitrification takes place, whereas it produces but feeble growth in sterile sand or water cultures, indicates that the plant requires nitrate nitrogen. Yet the experience gained in this investigation shows clearly that nitrates are not suitable fertilizers, not even potassium nitrate. Why these conflicting results?

The following is probably what takes place in the soil when ammonium sulphate is applied: The sulphuric acid combines with some other base in the soil, as in the example given at the end of this article, the ammonia is changed into nitric acid by means of nitrifying bacteria and that acid, like the sulphuric, also combines with some base. This would seem to produce a condition similar to that of an application of nitrates. But evidently it is different for the results are different. The theory is advanced that when no bases are present in the soil, with which nitric acid can combine, it will remain free in the soil solution. With that theory as a basis experiments were conducted for the purpose of ascertaining whether or not free nitric acid is absorbed by the plant. Slips were rooted in silica sand after which they were inserted in jars containing distilled water with nitric acid, about 100 parts per million. Tests were made for nitrates in the leaves at intervals and

the solution was analysed and renewed each week. Both tests showed that the pineapple plant can supply itself with nitrogen from nitric acid by means of its roots.

In another test fresh slips (not rooted) were inserted in jars with distilled water containing about 300 parts nitric acid per million. Tests as mentioned above demonstrated that considerable nitric acid was taken up through the leaf-bases and perhaps through the tip of the stalk, which was, in this case, not sealed over.

POTASSIUM. - This is, as mentioned in article No.7, needed in considerable quantity by the pineapple plant. Since that article was published experiments have been conducted for the purpose of finding out which potassium salts are the most suitable for fertilizing purposes. One of the first field experiments with potassium nitrate showed very conclusively that it is most unsuitable. Further experiments, both in the field and in pots, with silica sand, verified the first results. The growth produced is very vigorous for a time, but it lessens after a few months. The tissue is soft, watery and edemaceous. The leaves are twisted and usually the last formed stick together and stand up in a tuft. Sometimes they separate and spread out normally, but very often they adhere so closely that no new leaves can form. The color is always green without the intermixture of red found in the normal plant, that is until the leaves become too old to function normally. In general appearance the leaf is shiny similar to that of other species of plants suffering from edema.

The green color-characteristics are also transmitted to the fruit. The shape of that is long, tapering, resembling the sugar-loaf type. The slips are usually absent. When one or two are present they are short, not expanded but doubled up like a bent finger.

The conditions described, strongly indicate that potassium nitrate has too great a penetrating effect; that when used in quantities great enough to supply the nitrogen and potash needed by the pineapple plant the effect is harmful. On the other hand it suggests that, perhaps, when used in small quantities together with ammonium sulfate it may serve as a penetrant in plants that do not respond to ammonium sulfate alone. That has not yet been tried. But aside from such possible use potassium nitrate seems to be excluded from pineapple fertilizers where it is really not needed, for potassium sulfate is most excellent.

S O D I U M. - As sodium is also, closely related to potassium, it is reasonable to suppose that it may, to some extent, replace that in the plant's economy and this supposition has been verified by pot experiments. Plants growing in twelve-quart pails, in pure silica sand and fertilized with sodium salts and a minimum of potassium salts, contained very much more sodium than others grown with potassium salt and a minimum of sodium salts. The growth was not normal, however, the leaves being under-sized and pale in color like those of plants fertilized with sodium nitrate in the field. But the growth produced, together with the sodium content of

the plants, leave no doubt about sodium being, to some extent, a substitute for potassium. That the substitution is undesirable was well indicated by the growth of the plants. The most conspicuous feature was that as the plants grew older the leaves became dotted with white and brown spots, beginning at the margin and gradually spreading to the center. This is a physiological effect that may be produced by a number of causes. It usually denotes senescence of the tissue. Therefore, the effect of sodium is, in this respect, diametrically opposite to that of potassium. In other respects, there are also differences. Sodium inhibits the production of anthocyanin as does potassium but not to the same extent; the sodium plants and fruit are seldom entirely devoid of red color. The green color of the sodium plants is also of a much lighter shade than that of the potassium plants. In fact, it often borders upon actual chlorosis.

C A L C I U M. - This being a cheap base it is used, to some extent, for fertilizing purposes in the form of calcium nitrate. This form of nitrate seems less objectionable than potassium or sodium nitrate to judge from the appearance of the plants. There is nothing to indicate, however, that it can economically replace ammonium sulphate. The effect of it seems to be similar to that of sodium in some respects. In pot experiments the plants that received much calcium and little potassium contained those elements in proportion to the application. That is, lime seemed to substitute potash with the result that the leaves developed the white and brown spots such as are also produced by sodium. That such substitution also takes place in the field is indicated by the high lime and low potash content of many abnormal plants. Yet the soil content does not always explain the reason for it. There seems to be factors involved aside from that of quantity present. The following example will serve to illustrate one such factor: A soil containing an excess calcium carbonate is fertilized with ammonium sulfate. The ammonia is nitrified and the sulfuric acid, as well as the nitric acid formed, will combine with the calcium, the carbon dioxid going off in gaseous form or remaining dissolved in the soil water. This will leave calcium nitrate as the source from which the plant will have to supply itself. It may do so, and grow fairly well, at least for a time, if there is no more calcium carbonate present. If there is, the growth will be slow and the color chlorotic for the plant cannot feed normally from a basic solution. If, on the other hand, such soil is treated with sulfur to the extent of neutralizing the lime or in excess, making the reaction slightly acid, the plants will feed normally regardless of the amount of calcium sulfate present. That is, the sulfur acts not alone as a floculent of colloidal matter, as explained in Article No.10, but also it serves to neutralize the calcium when that is present as calcium carbonate. If enough sulfur is applied to neutralize the calcium carbonate or any other carbonates present there will be no base with which nitric acid can combine. That would insure a continual acid reaction of the soil solution, which is favorable for the growth of the plant. Whether or not free nitric acid is the most suitable form of nitrogen for the plant remains to be proved. That the plant can utilize it has been proved as described above.